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TITLE: METHOD AND SYSTEM FOR COMMUNICATING DATA OVER A WIRELESS COMMUNICATION SYSTEM VOICE CHANNEL UTILIZING FRAME GAPS

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METHOD AND SYSTEM FOR COMMUNICATING DATA OVER A WIRELESS COMMUNICATION SYSTEM VOICE CHANNEL UTILIZING FRAME GAPS

FIELD OF THE INVENTION

This invention relates generally to wireless communications. More specifically, the invention relates to a method and system for communicating data over a wireless communication system voice channel utilizing frame gaps.

BACKGROUND OF THE INVENTION

The opportunity to utilize wireless features is ever increasing as cellular transceivers are being transformed into entertainment as well as communication platforms. Typically, wireless systems within mobile vehicles (e.g., telematics units) provide voice communication. Recently, these wireless systems have been utilized to update systems within telematics units such as, for example, radio station presets. Such use requires transmission of data.

Cellular transceivers operate within communication systems, for example a telematics unit within a mobile vehicle operating within a mobile vehicle communication system (MVCS). Conventional MVCSs heretofore have operated utilizing analog signal technology. Recently, many MVCSs have upgraded to digital technology allowing the upgraded MVCS to operate more efficiently. Unfortunately, MVCSs utilizing digital technology have experienced some undesired effects such as, for example, the inability to effectively transmit data through a voice channel of a communication network due to a system vocoder completely attenuating the signal because the signal is interpreted as background noise..

The present invention advances the state of the art in cellular transceivers.

SUMMARY OF THE INVENTION

One aspect of the invention includes a method of communicating data over a voice channel of a wireless communication system. The method includes receiving a first periodic data signal and modulating the first periodic data signal to produce a second periodic data signal. The modulation includes inserting a predetermined silence period at timed intervals into the first periodic data signal to produce the second periodic data signal. The method further includes communicating the second periodic data signal over the voice channel of the wireless communication system.

In accordance with another aspect of the invention, a computer readable medium storing a computer program includes the following: computer readable code for directing the reception of a first periodic data signal; computer readable code for modulating the first periodic data signal to produce a second periodic data signal, wherein the modulation includes inserting a predetermined silence period at timed intervals into the first periodic data signal to produce the second periodic data signal; and computer readable code for communicating the second periodic data signal over the voice channel of the wireless communication system.

Yet another aspect in accordance with the present invention is a system for providing communication data over a voice channel of a wireless communication system. The system includes means for receiving a first periodic data signal; means for modulating the first periodic data signal to produce a second periodic data signal, wherein the modulation includes inserting a predetermined silence period at periodic intervals into the second periodic data signal; and means for communicating the second periodic data signal over the voice channel of the wireless communication system is also provided.

The aforementioned, and other features and advantages of the invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the invention rather than limiting, the scope of the invention being defined by the appended claims and equivalents thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates one embodiment of a system for providing communication data over a voice channel of a wireless communication system, in accordance with the present invention;

FIG. 2 is a block diagram illustrating a system for producing an altered protocol transmission, in accordance with the present invention;

FIG. 3 is a waveform diagram of an unaltered protocol transmission;

FIG. 4 is a waveform diagram of the altered protocol transmission, in accordance with the present invention; and

FIG. 5 is a flow diagram of one embodiment of a method of communicating data over a voice channel of a wireless communication system utilizing frame gaps, in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates one embodiment of system for data transmission over a wireless communication system, in accordance with the present invention at **100**. System **100** includes a mobile vehicle communication unit (MVCU) **110**, a vehicle communication network **112**, a telematics unit **120**, one or more wireless carrier systems **140**, one or more communication networks **142**, one or more land networks **144**, one or more client, personal, or user computers **150**, one or more web-hosting portals **160**, and one or more call centers **170**. System **100** may include additional components not relevant to the present discussion.

In one embodiment, MVCU **110** is implemented as a mobile vehicle equipped with suitable hardware and software for transmitting and receiving voice and data communications. Therefore, MVCU **110** is also referred to as a mobile vehicle in the discussion below. In operation, MVCU **110** may be implemented as a motor vehicle, a marine vehicle, or an aircraft. Additionally, to practice the present invention in its simplest form, MVCU **110** can be implemented as a conventional cellular transceiver such as, for example, a cellular telephone. MVCU **110** may include additional components not relevant to the present discussion.

MVCU **110**, via a vehicle communication network **112**, sends signals to various units of equipment and systems within MVCU **110** to perform various functions such as unlocking a door, opening the trunk, setting personal comfort settings, and calling from telematics unit **120**. In facilitating interactions among the various communication and electronic modules, vehicle communication network **112** utilizes network interfaces such as controller-area network (CAN), International Organization for Standardization (ISO) Standard 9141, ISO Standard 11898 for high-speed applications, ISO Standard 11519 for lower speed applications, and Society of Automotive Engineers (SAE) Standard J1850 for high-speed and lower speed applications.

MVCU **110**, via telematics unit **120**, sends to and receives radio transmissions from wireless carrier system **140**. Wireless carrier system **140** is implemented as any suitable system for transmitting a signal from MVCU **110** to communication network **142**.

Telematics unit **120** includes a digital signal processor (DSP) **122** connected to a wireless modem **124**, a global positioning system (GPS) unit **126**, an in-vehicle memory **128**, a microphone **130**, one or more speakers **132**, and an embedded or in-vehicle mobile phone **134**. In other embodiments, telematics unit **120** may be implemented without one or more of the above listed components, for example speakers **132**. Telematics unit **120** may include additional components not relevant to the present discussion.

In one embodiment, DSP **122** is implemented as a microcontroller, controller, host processor, or vehicle communications processor. In an example, DSP **122** is implemented as an application specific integrated circuit (ASIC). In another embodiment, DSP **122** is implemented as a processor working in conjunction with a central processing unit (CPU) performing the function of a general purpose processor.

DSP **122** executes various computer programs that control programming and operational modes of electronic and mechanical systems within MVCU **110**. DSP **122** controls communications (e.g., call signals) between telematics unit **120**, wireless carrier system **140**, and call center **170**. In one embodiment, a voice-recognition application is installed in DSP **122** that can translate human voice input through microphone **130** to digital signals.

DSP **122** generates and accepts digital signals transmitted between telematics unit **120** and a vehicle communication network **112** that is connected to various electronic modules in the vehicle. In one embodiment, these digital signals activate the programming mode and operation modes, as well as provide for data transfers such as, for example, data over voice channel communication. DSP **122** is capable of modulating a periodic data signal by inserting predetermined silence periods, also called frame gaps, into the signal to produce a second periodic data signal that is configured for transmission over a voice channel. **FIG. 2**, discussed below, illustrates a signal control device **210** for modulating a periodic data signal that is implemented as a digital signal processor. In the present embodiment, computer readable code for effecting modulation and transmitting the modulated signal is stored in in-vehicle memory **128**.

GPS unit **126** provides longitude and latitude coordinates, as well as a time stamp, of the vehicle responsive to a GPS broadcast signal received from one or more GPS satellite broadcast systems (not shown). In-vehicle mobile phone **134** is a cellular-type phone such as, for example, a digital, dual-mode (e.g., analog and digital), dual-band, multi-mode or multi-band cellular phone.

Communication network **142** includes services from one or more mobile telephone switching offices and wireless networks. Communication network **142** connects wireless carrier system **140** to land network **144**. Communication network **142** is implemented as any suitable system or collection of systems for connecting wireless carrier system **140** to MVCU **110** and land network **144**.

Land network **144** connects communication network **142** to client computer **150**, web-hosting portal **160**, and call center **170**. In one embodiment, land network **144** is a public-switched telephone network (PSTN). In another embodiment, land network **144** is implemented as an Internet protocol (IP) network. In other embodiments, land network **144** is implemented as a wired network, an optical network, a fiber network, other wireless networks, or any

combination thereof. Land network **144** is connected to one or more landline telephones. Communication network **142** and land network **144** connect wireless carrier system **140** to web-hosting portal **160** and call center **170**.

Client, personal, or user computer **150** includes a computer usable medium to execute Internet browser and Internet-access computer programs for sending and receiving data over land network **144** and, optionally, wired or wireless communication networks **142** to web-hosting portal **160**. Client computer **150** sends user preferences to web-hosting portal **160** through a web-page interface using communication standards such as hypertext transport protocol (HTTP), and transport-control protocol and Internet protocol (TCP/IP). In operation, a client utilizes computer **150** to initiate setting or re-setting of user preferences for MVCU **110**. User-preference data from client-side software is transmitted to server-side software of web-hosting portal **160**. User-preference data is stored at web-hosting portal **160**.

Web-hosting portal **160** includes one or more data modems **162**, one or more web servers **164**, one or more databases **166**, and a network system **168**. Web-hosting portal **160** is connected directly by wire to call center **170**, or connected by phone lines to land network **144**, which is connected to call center **170**. In an example, web-hosting portal **160** is connected to call center **170** utilizing an IP network. In this example, both components, web-hosting portal **160** and call center **170**, are connected to land network **144** utilizing the IP network. In another example, web-hosting portal **160** is connected to land network **144** by one or more data modems **162**. Land network **144** sends digital data to and receives digital data from modem **162**, data that is then transferred to web server **164**. Modem **162** may reside inside web server **164**. Land network **144** transmits data communications between web-hosting portal **160** and call center **170**.

Web server **164** receives user-preference data from client computer **150** via land network **144**. In alternative embodiments, computer **150** includes a wireless modem to send data to web-hosting portal **160** through a wireless communication network **142** and a land network **144**. Data is received by land network **144** and sent to one or more web servers **164**. In one embodiment, web server **164** is implemented as any suitable hardware and software capable of providing web services to help change and transmit personal preference settings from a client at computer **150** to telematics unit **120** in MVCU **110**. Web server **164** sends to or receives from one or more databases **166** data transmissions via network system **168**. Web server **164** includes computer applications and files for managing and storing personalization settings supplied by the client.

In one embodiment, one or more web servers **164** are networked via network system **168** to distribute user-preference data among its network components such as database **166**. In an example, database **166** is a part of or a separate computer from web server **164**. Web server **164** sends data transmissions with user preferences to call center **170** through land network **144**.

Call center **170** is a location where many calls are received and serviced at the same time, or where many calls are sent at the same time. In one embodiment, the call center is a telematics call center, facilitating communications to and from telematics unit **120** in MVCU **110**. In an example, the call center is a voice call center, providing verbal communications between an advisor in the call center and a subscriber in a mobile vehicle. In another example, the call center contains each of these functions. In other embodiments, call center **170** and web-hosting portal **160** are located in the same or different facilities.

Call center **170** contains one or more voice and data switches **172**, one or more communication services managers **174**, one or more communication services databases **176**, one or more communication services advisors **178**, and one or more network systems **180**.

Switch **172** of call center **170** connects to land network **144**. Switch **172** transmits voice or data transmissions from call center **170**, and receives voice or data transmissions from telematics unit **120** in MVCU **110** through wireless carrier system **140**, communication network **142**, and land network **144**. Switch **172** receives data transmissions from and sends data transmissions to one or more web-hosting portals **160**. Switch **172** receives data transmissions from or sends data transmissions to one or more communication services managers **174** via one or more network systems **180**.

Communication services manager **174** is any suitable hardware and software capable of providing requested communication services to telematics unit **120** in MVCU **110**. Communication services manager **174** sends to or receives from one or more communication services databases **176** data transmissions via network system **180**. Communication services manager **174** sends to or receives from one or more communication services advisors **178** data transmissions via network system **180**. Communication services database **176** sends to or receives from communication services advisor **178** data transmissions via network system **180**. Communication services advisor **178** receives from or sends to switch **172** voice or data transmissions.

Communication services manager **174** provides one or more of a variety of services, including communicating data over a voice channel of a wireless communication system utilizing frame gaps, carrying out an initial data link authentication process, enrollment services, navigation assistance, directory assistance, roadside assistance, business or residential assistance, information services assistance, emergency assistance, and communications assistance. In the present embodiment, communications services manager **174** includes software for receiving a periodic data signal, modulating the signal using frame gaps, and communicating the modulated signal over a wireless communication system voice channel.

Communication services manager **174** receives service-preference requests for a variety of services from the client via computer **150**, web-hosting portal **160**, and land network **144**. Communication services manager **174** transmits user-preference and other data to telematics unit **120** in MVCU **110** through wireless carrier system **140**, communication network **142**, land network **144**, voice and data switch **172**, and network system **180**. Communication services manager **174** stores or retrieves data and information from communication services database **176**. Communication services manager **174** may provide requested information to communication services advisor **178**.

In one embodiment, communication services advisor **178** is implemented as a real advisor. In an example, a real advisor is a human being in verbal communication with a user or subscriber (e.g., a client) in MVCU **110** via telematics unit **120**. In another embodiment, communication services advisor **178** is implemented as a virtual advisor. In an example, a virtual advisor is implemented as a synthesized voice interface responding to requests from telematics unit **120** in MVCU **110**.

Communication services advisor **178** provides services to telematics unit **120** in MVCU **110**. Services provided by communication services advisor **178** include enrollment services, navigation assistance, real-time traffic advisories, directory assistance, roadside assistance, business or residential assistance, information services assistance, emergency assistance, automated vehicle diagnostic function, and communications assistance. Communication services advisor **178** communicates with telematics unit **120** in MVCU **110** through wireless carrier system **140**, communication network **142**, and land network **144** using voice transmissions, or through communication services manager **174** and switch **172** using data transmissions. Switch **172** selects between voice transmissions and data transmissions.

In operation, an incoming call is routed to telematics unit **120** within mobile vehicle **110** from call center **170**. In one embodiment, the call is routed to telematics unit **120** from call center **170** via land network **144**, communication network **142**, and wireless carrier system **140**.

In one embodiment, system **100** utilizes a network transmission standard such as, for example a Code Division Multiple Access (CDMA) transmission standard. In other embodiments, the system utilizes network transmission standards such as, for example Time Division Multiple Access (TDMA), Frequency Division Multiple Access, or Groupe Speciale Mobile (GSM) also referred to as Global System for Mobile (GSM) communication.

FIG. 2 is a block diagram illustrating a system **200** for modulating a periodic data signal in accordance with the present invention. **FIG. 2** shows a signal control device **210** that receives a periodic data signal in the form of a protocol transmission $S_{in}(t)$ (detailed in **FIG. 3**) and a control signal C(t), and produces an altered protocol transmission $S_{out}(t)$ (detailed in **FIG. 4**). In one embodiment, signal control device **210** is implemented as a digital signal processor as is known in the art.

In an example, signal control device **210** modulates the protocol transmission $S_{in}(t)$ by inserting a predetermined silence period at timed intervals to produce the altered protocol transmission $S_{out}(t)$. In this example, inserting the predetermined silence period at timed intervals is accomplished responsive to the control signal C(t). As noted above, the predetermined silence periods are referred to as frame gaps.

FIG. 3 is a waveform diagram of protocol transmission $S_{in}(t)$. In an example, protocol transmission $S_{in}(t)$ is a periodic data signal such as, for example, a calling tone for data link establishment. In another example, the protocol transmission $S_{in}(t)$ is a data sequence modulated through frequency shift keying.

FIG. 4 is a waveform diagram of the modulated protocol transmission $S_{out}(t)$ including time indices that are presented for illustrative purposes and are not intended to be limiting. In **FIG. 4**, time index (t_0-t_6) represents a specific time increment of altered protocol transmission $S_{out}(t)$. Time index (t_0-t_1) represents a time increment when control signal C(t) instructs signal control device **210** to pass a portion of protocol transmission $S_{in}(t)$, a protocol transmission period, to the output of signal control device **210**. Time index (t_1-t_2) represents a time increment when control signal C(t) instructs signal control device **210** to pass a silence period to the output of control device **210**. The combination of the protocol transmission period and the silence period results in the production of altered protocol transmission $S_{out}(t)$ as illustrated in **FIG. 4**.

The silence periods (t_1-t_2), (t_3-t_4), and (t_5-t_6) created by signal control device **210** based on received input from control signal C(t) are periodic and of a predetermined length. The protocol transmission periods (t_0-t_1), (t_2-t_3), and (t_4-t_5) created by signal control device **210** based on received input from control signal C(t) are periodic and of a predetermined length. In an example, the silence periods (t_1-t_2), (t_3-t_4), and (t_5-t_6) created by signal control device **210** have a duration from about 25 millisecond to about 1000 millisecond. In this example, protocol transmission periods (t_0-t_1), (t_2-t_3), and (t_4-t_5) created by signal control device **210** have a duration from about 1 second to about 3 seconds. In operation, the altered protocol transmission $S_{out}(t)$ provides a continuous modulated data signal for transmission over a voice channel of a wireless communication system. The periodic silence periods within altered protocol transmission $S_{out}(t)$ allow the wireless communication system to overcome problems inherent within wireless communication systems such as, for example, a wireless communication system's vocoder identifying an unaltered protocol transmission $S_{in}(t)$ as noise and initiating a noise reduction algorithm to attenuate the protocol transmission $S_{in}(t)$.

FIG. 5 is a flow diagram of one embodiment of a method of communicating data over a voice channel of a wireless communication system. In **FIG. 5**, method **500** may utilize one or more systems and concepts detailed in **FIGS 1–4**, above. The present invention can also take the form of a computer usable medium including a program for configuring an electronic module within a vehicle. The program stored in the computer usable medium includes computer program code for executing the method steps described in **FIG. 5**. In **FIG. 5**, method **500** begins at step **510**.

At step **520**, a first periodic data signal is received. In one embodiment, the first periodic data signal is received at a signal control device. In an example and referring to **FIGS. 2** and **3** above, the first periodic data signal is a protocol transmission $S_{in}(t)$ that is received at signal control device **210**. In another embodiment, the first periodic data signal is a data sequence modulated through frequency shift keying.

At step **530**, the first periodic data signal is modulated to produce a second periodic data signal. The modulation includes inserting a predetermined silence period (the period being, for example, from about 25 milliseconds to about 1000 milliseconds) at timed intervals into the first periodic data signal to produce the second periodic data signal. In one embodiment, the first periodic data signal is modulated to produce the second periodic data signal by utilizing a control signal to insert the predetermined silence period at periodic intervals into the first periodic data signal. In an example and referring to **FIG. 2**, the step of modulation includes signal control device **210** receiving a control signal C(t) that includes parameters for a length of the predetermined silence period and timing of the periodic intervals. In this example, signal control device **210** modulates the first periodic data signal responsive to the received control signal and produces the second periodic data signal. In another embodiment and detailed in step **550** below, the predetermined silence period utilized in the modulation is variable.

At step **540**, the second periodic data signal is communicated over the voice channel of the wireless communication system. The system utilizes network transmission standards such as, for example Time Division Multiple Access (TDMA), Frequency Division Multiple Access, or Groupe Speciale Mobile (GSM) also referred to as Global System for Mobile (GSM) communication. In one embodiment, the second periodic data signal is a first component of an initial data link authentication process. In another embodiment, communicating the second periodic data signal over the voice channel of the wireless communication system includes transmitting the second periodic data signal over the voice channel of the wireless communication system, receiving the second periodic data signal at a transceiver, and receiving a third periodic data signal from the transceiver. In this embodiment, the third periodic data signal is a second component of an initial data link authentication process.

At optional step **550**, the received response is utilized as a basis for varying the modulation of step **530**, above. Varying the modulation includes varying the predetermined silence period length responsive to the response received in step **540**, above.

In an example and referring to **FIGS 2–4** above, if a predetermined silence period length is not great enough to allow a wireless communication system's vocoder to correctly identify an altered protocol transmission $S_{out}(t)$, the length of the predetermined silence period can be increased until the altered protocol transmission $S_{out}(t)$ is properly identified.

At step **560**, the method is terminated.

The above-described methods and implementation for initiating data over voice channel wireless communication utilizing frame gaps are example methods and implementations. These methods and implementations illustrate one possible approach for initiating data over voice channel wireless communication utilizing frame gaps. The actual implementation may vary from the method discussed. Moreover, various other improvements and modifications to this

invention may occur to those skilled in the art, and those improvements and modifications will fall within the scope of this invention as set forth in the claims below.

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive.